CHAPTER 4. SCREENING ANALYSIS

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 4. SCREENING ANALYSIS

4.1 INTRODUCTION

This chapter discusses the screening analysis conducted by the U.S. Department of Energy (DOE) of the technology options identified in the market and technology assessment for residential cooking products[a] (chapter 3 of this technical support document (TSD)). In the market and technology assessment, DOE presented an initial list of technology options that can be used to reduce energy consumption of each of the products covered in this rulemaking. The goal of the screening analysis is to identify any technologies that will be eliminated from further consideration in the rulemaking analyses. As described in section 1.3 of chapter 1 of this TSD, DOE is continuing the rulemaking for energy conservation standards for commercial clothes washers and microwave oven standby power, and analyses related to these products will be published in separate TSDs.

For each product, the corresponding candidate technology options are assessed based on DOE analysis as well as inputs from interested parties, including manufacturers, trade organizations, and energy efficiency advocates. Technology options that are judged to be viable approaches for improving energy efficiency are retained as inputs to the subsequent engineering analysis, and are designated as design options. Technology options that are not incorporated in commercial products or in working prototypes, or that fail to meet certain criteria as to practicability to manufacture, install and service, as to impacts on product utility or availability, or as to health or safety will be eliminated from consideration in accordance with *Energy Conservation Program for Consumer Products: Procedures for Consideration of New or Revised Energy Conservation Standards for Consumer Products*. 61 FR at 36974 (July 15, 1996). The rationale for either screening out or retaining each technology option is detailed in the following sections.

4.2 DISCUSSION OF TECHNOLOGY OPTIONS

For residential cooking products, information used for applying the screening criteria to most of the technology options was derived from the previous rulemaking's TSD, DOE's 1996 *Technical Support Document for Residential Cooking Products* (1996 TSD). The framework document for this rulemaking, entitled *Rulemaking Framework for Commercial Clothes Washers and Residential Dishwashers, Dehumidifiers, and Cooking Products*, March 15, 2006, describes which technology options DOE reevaluated for the engineering analysis in the current rulemaking. The approach proposed in the framework document for conventional cooking products is to retain the same screening results as put forth in the 1996 TSD. In addition, low-

[a] The term "cooking products" refers to residential electric and gas kitchen ranges and ovens, including microwave ovens. The term "conventional cooking products" refers to cooking products other than microwave ovens.

standby-loss electronics, which DOE identified for cooking products through literature searches and interested parties' inputs, were evaluated. It should also be noted that radiant elements for smooth cooktops, which were included as a technology option in the 1996 TSD, were not included in the current rulemaking because manufacturer data provided to DOE for the 1996 TSD indicated that this technology did not demonstrate an efficiency improvement over the baseline according to the DOE test procedure, and DOE is unaware of any more recent data that indicates otherwise.

For microwave ovens, technology options from the 1996 TSD for improving energy factor (EF) were screened in the same manner as in the previous rulemaking. However, three additional technologies——cooking sensors, dual magnetrons, and low-standby-loss electronic controls—were evaluated. DOE identified cooking sensors from product literature, while dual magnetrons were added based on information from the February 2006 edition of *Appliance Design*. DOE identified low-standby-loss electronic controls by reviewing the Association of Home Appliance Manufacturers (AHAM) data for standby power.

4.2.1 Screened-Out Technology Options

The following section details the specific technology options that were screened out prior to the engineering analysis, along with the rationale for elimination.

The technologies identified in the market and technology assessment were evaluated pursuant to the criteria set out in the Energy Policy and Conservation Act (EPCA) for prescribing new or amended standards which will achieve the maximum improvement in energy efficiency the Secretary of Energy determines is technologically feasible. (42 U.S.C. 6295(o)(2)(A)) It also establishes guidelines for determining whether a standard is economically justified. (42 U.S.C. 6295(o)(2)(B)(i)) In view of the EPCA requirements for determining whether a standard is technologically feasible and economically justified, appendix A to subpart C of Title 10 Code of Federal Regulations part 430 (10 CFR part 430), *Procedures, Interpretations and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products* (the "Process Rule"), sets forth procedures to guide DOE in the consideration and promulgation of new or revised product energy conservation standards under EPCA. These procedures elaborate on the statutory criteria provided in 42 U.S.C. 6295(o)(2) and, in part, eliminate problematic technologies early in the process of revising an energy conservation standard. Under the guidelines, before publishing an advance notice of proposed rulemaking (ANOPR), DOE eliminates from consideration technologies that present unacceptable problems with respect to the following four factors:

(1) Technological feasibility. If it is determined that a technology has not been incorporated in commercial products or in working prototypes, then that technology will not be considered further.

(2) Practicability to manufacture, install, and service. If it is determined that mass production of a technology in commercial products and reliable installation and servicing of the

technology could not be achieved on the scale necessary to serve the relevant market at the time of the effective date of the standard, then that technology will not be considered further.

(3) Impacts on product utility to consumers. If a technology is determined to have significant adverse impact on the utility of the product to significant subgroups of consumers, or results in the unavailability of any covered product type with performance characteristics (including reliability), features, size, capacities, and volumes that are substantially the same as products generally available in the United States at the time, it will not be considered further.

(4) Safety of technologies. If it is determined that a technology will have significant adverse impacts on health or safety, it will not be considered further.

The following sections detail the technology options that were screened out for each product class covered by this rulemaking and the reasons why each were eliminated.

4.2.1.1 Gas Cooktops

For gas cooktops, DOE screened out catalytic burners, radiant gas burners, reduced excess air at burner, and reflective surfaces for the reasons that follow.

Catalytic burners

DOE is not aware of any commercialized catalytic burners for gas cooktops, so DOE believes that it would not be practicable to manufacture, install and service this technology on the scale necessary to serve the relevant market at the time of the effective date of an amended standard. Also, because this technology is in the research stage, it is not possible to assess whether it will have any adverse impacts on utility to consumers or product availability, or any adverse impacts on consumers' health or safety.

Radiant gas burners

In the previous rulemaking, manufacturers asserted that the operating characteristics of an infrared (IR)-jet radiant burner are such that it is difficult to maintain a low burner input rate for many cooktop functions. They stated that field testing for residential ranges was discontinued because test users were unable to turn down the burner satisfactorily.[1] Without an adequate “turn down” capability, the burner would not be able to pass the American National Standards Institute (ANSI) Standard Z21.1-2005, *Household Cooking Gas Appliances*.

Although a silicon carbide radiant burner has been tested to the Japanese Industrial Standard (JIS) S 2103:1996, *Gas burning cooking appliances for domestic use*, it is also not known how either type of radiant burner would perform under DOE test conditions. Since DOE lacks relevant test data to evaluate potential impacts on consumers’ health and safety, this technology option was not analyzed for gas cooktops.

Reduced excess air at burner

For the 1996 TSD, the Gas Research Institute (GRI, now known as the Gas Technology Institute) submitted a report that analyzed this technology option and was submitted as a comment to the NOPR in the previous rulemaking.[2] GRI concluded that the efficiency increase of this technology option was not measurable at that time. They pointed out that the burner described by DOE did not exist on the market and thus there were no designs that could be evaluated. DOE is unaware of any changes to that situation. GRI also noted that use of this technology option may cause a safety issue due to the possibility of increased carbon monoxide production.

Reduced excess air at the burner has not been commercialized, and DOE believes that it would not be practicable to manufacture, install and service this technology on the scale necessary to serve the relevant market at the time of the effective date of an amended standard. Also, because this technology is undeveloped, it is not possible to assess whether it will have any adverse impacts on utility to consumers or product availability, or any adverse impacts on consumers' health or safety. .

Reflective surfaces

As reported in the 1996 TSD, manufacturers stated that any increase in efficiency due to a reflective surface could easily be negated if the consumer fails to regularly clean the surface or uses an abrasive pad to clean the surface. Therefore, it would be necessary to replace reflective pans periodically at a high replacement cost. Also, because this technology has not been commercialized, it is not possible to assess whether it will have any other adverse impacts on utility to consumers or product availability or any adverse impacts on consumers' health or safety.

4.2.1.2 Electric Open (Coil) Cooktops

For electric open (coil) cooktops, DOE screened out reflective surfaces, for the reasons that follow.

Reflective surfaces

As reported in the 1996 TSD, manufacturers stated that any increase in efficiency due to a reflective surface could easily be negated if the consumer fails to regularly clean the surface or uses an abrasive pad to clean the surface. Therefore, it would be necessary to replace reflective pans periodically at a high replacement cost. Also, because this technology has not been commercialized, it is not possible to assess whether it will have any other adverse impacts on utility to consumers or product availability, or any adverse impacts on consumers' health or safety.

4.2.1.3 Electric Smooth Cooktops

For electric smooth cooktops, all technologies meet the screening criteria.

4.2.1.4 Electric and Gas Ovens

For electric and gas, DOE screened out added insulation, bi-radiant oven, halogen lamp oven, no oven door window, oven separator, reduced thermal mass, and reflective surfaces, for the reasons that follow.

Added insulation

Although some analyses indicated energy consumption could be reduced by increasing the thickness of the insulation in the cabinet walls and doors from 2 inches to 4 inches, consumer utility would be negatively impacted, since the oven cavity volume would have to be reduced to maintain standardized exterior dimensions. The reduced oven cavity volume would limit the size of large items that could be cooked in the oven. For this reason, this technology option was not analyzed. However, it should be noted that improved insulation, consisting of higher-density insulation with the baseline 2-inch thickness, was still analyzed for standard gas and electric ovens. This higher-density insulation is already used for self-clean gas and electric ovens.

Bi-radiant oven (electric only)

The 1996 TSD assumed that three major conditions would have to be met in order to consider the bi-radiant oven as a viable technology option. These included the use of (1) low-emissivity cavity lining materials; (2) electronic controls; and (3) highly-absorptive baking and roasting utensils. While electronic controls are currently in widespread use in electric ovens, cavity maintenance issues and the requirement for specialized cookware negatively impact consumer utility. In addition, there is currently no such product on the market and the last working prototype known to DOE was tested in the 1970s.

Halogen lamp oven (electric only)

While GE Consumer & Industrial (GE) currently markets a line of electric ovens that incorporates halogen elements along with conventional resistance heating elements, microwave heating, and a convection system, DOE is not aware of any ovens that utilize halogen lamps alone as the heating element, and no data were found or submitted to demonstrate how efficiently halogen elements alone perform relative to conventional ovens. DOE believes that it would not be practicable to manufacture, install and service halogen lamps for use in consumer cooking products on the scale necessary to serve the relevant market at the time of the standard's effective date.

No oven door window

GRI issued a topical report[3] that discussed this technology option in the previous rulemaking. The report was submitted as a written comment to the associated NOPR. GRI's experimental tests showed a small savings in annual energy usage (increase in efficiency) for both the standard and self-clean ovens by eliminating the door window. However, GRI reported there could actually be a net energy loss due to consumer practices, which would be a function of the number of times a consumer would open the door to inspect the food while cooking. With four door openings per test (per the DOE test procedure), a standard oven would realize a net energy savings of 34 thousand British thermal units per year (kBtu/yr). For a self-clean oven there is a net energy loss of 3 kBtu/yr. The report also stated there would be reduced consumer utility and the possibility of failure of delicate food items (*e.g.*, soufflés), as well as decreased safety without the window due to increased risk of burns from additional door openings while the oven is in use.

Oven separator

U.S. manufacturers stated in the previous rulemaking that the use of an oven separator has been researched but has never been put into production because of problems it would cause both manufacturers and consumers. With regard to conventional gas ovens, manufacturers stated that the separator could not be economically designed for improved efficiency, though an acceptable design for gas convection ovens might be possible. With regard to electric ovens, manufacturers asserted that the separator would require the installation of an additional element and a non-conventional oven-control system. Manufacturers also stated that it would be difficult to obtain Underwriters Laboratory (UL) and American Gas Association (AGA) approvals and meet existing ANSI standards because of the effect the separator would have on safety and performance. Manufacturers further stated that consumer acceptance would probably be low because appliances such as microwave and toaster ovens already exist to cook small loads. In addition, the separator would have to be designed to be "fool-proof" to prevent consumers from accidentally installing it incorrectly. With regard to energy use, the additional metal added to the oven by the separator (increased thermal mass) might result in increased energy losses, although data provided by AHAM indicated an increase in efficiency of approximately 0.82 percentage points in an electric oven. However, the anticipated negative impacts on consumer utility and safety, along with practicability to manufacture, resulted in DOE screening out the oven separator from further analysis.

Reduced thermal mass

Manufacturers commented in the 1996 TSD that thermal mass reduction was not possible for then-manufactured electric and gas ovens. They stated that the oven walls must provide strong enough support to hold racks when baking heavy items (*i.e.*, turkeys or large roasts.) Oven metal gauges could not be reduced any further without risking cracking and greater heat losses.[4] DOE believes this situation is still the case in current ovens. Due to issues of structural integrity during use and transportation as well as the issue of consumer product safety, this technology option was not analyzed.

Reflective surfaces

Manufacturers stated in the previous rulemaking that it has been very difficult to obtain satisfactory cooking performance with reflective surfaces. The reflective materials degrade after the first baking function and continue to degrade through the life of the product. This is especially true of self-cleaning ovens, as the self-cleaning process damages the reflective walls and negates any possible energy savings.[5]

GRI[6] performed tests on this technology option that measured a decrease in energy efficiency. The reflective surface interfered with the convective currents and the thermostat, thus fooling the thermostat into cycling. GRI reported that increased reflectance from the chrome-plated inner surface of the oven caused repeated thermostat cycling that "might have contributed to the higher energy consumption" which resulted in a 12.61 percent decrease in energy efficiency. Arthur D. Little Inc. (ADL)[7] also commented that the reflected radiation was different from the normal radiation emitted by the oven cavities in use at the time.

Based on these studies, it is uncertain whether, or how much, energy savings is realizable with this technology option. A smarter controller for the oven could potentially compensate for the thermostat problems. However, there is a general lack of sophistication in the technology in terms of maintaining clean, reflective surfaces over the lifetime of the product. For these reasons, this technology option was not analyzed.

4.2.1.5 Microwave Ovens

For microwave ovens, all technologies which impact EF meet the screening criteria.

4.2.2 Remaining Design Options

The following sections list the technology options for each product class covered by this rulemaking that were retained by DOE and subsequently designated as design options. Each of these technologies were evaluated further in the subsequent engineering analysis.

4.2.2.1 Gas Cooktops

For gas cooktops, DOE retained the technologies listed below for further analysis.

Table 4.2.1 Retained Design Options for Gas Cooktops

1. Electronic ignition
2. Insulation
3. Sealed burners
4. Thermostatically controlled burners

4.2.2.2 Electric Open (Coil) Cooktops

For electric open (coil) cooktops, DOE considered the following design options for further analysis.

Table 4.2.2 Retained Design Options for Electric Open (Coil) Element Cooktops

1. Electronic controls
2. Improved contact conductance
3. Insulation
4. Low-standby-loss electronic controls

4.2.2.3 Electric Smooth Cooktops

For electric smooth cooktops, DOE retained the following technologies for further analysis.

Table 4.2.3 Retained Design Options for Electric Smooth Element Cooktops

1. Electronic controls
2. Halogen elements
3. Induction elements
4. Low-standby-loss electronic controls

4.2.2.4 Electric and Gas Ovens

For electric and gas ovens, DOE retained the following technologies for further analysis.

Table 4.2.4 Retained Design Options for Electric and Gas Ovens

1. Forced convection
2. Improved door seals
3. Improved insulation
4. Low-standby-loss electronic controls
5. Pilotless ignition (gas only)
6. Radiant burner (gas only)
7. Reduced conduction losses
8. Reduced vent rate
9. Steam cooking

4.2.2.5 Microwave Ovens

For microwave oven energy factor, DOE retained the technologies listed below for further analysis.

Table 4.2.5 Retained Design Options for Microwave Ovens–Energy Factor

1. Added insulation
2. Cooking sensors
3. Dual magnetrons
4. Eliminate or improve ceramic stirrer cover
5. Improved fan efficiency
6. Improved magnetron efficiency
7. Improved power supply efficiency
8. Low-standby-loss electronic controls
9. Modified wave guide
10. Reflective surfaces

REFERENCES

[1] U.S. Department of Energy (U.S. DOE). 1998. *Technical Support Document: Energy Conservation Standards for Consumer Products: Cooking Products*, Washington, DC, September, 1998.

[2] Gas Research Institute (GRI). 1994. *Topical Report: Technical Input to NAECA Rulemaking for Gas-Fired Ranges*. Prepared by Battelle, Columbus, OH, American Gas Association Laboratories, Cleveland, OH, and Arthur D. Little, Cambridge, MA for Gas Appliance Technology Center, Chicago, IL, submitted as comment No. 001 to the NOPR, GRI-94/0195, July 1994.

[3] *Ibid.*

[4] U.S. DOE. 1998. *Op. cit.*

[5] *Ibid.*

[6] GRI. 1994. *Op. cit.*

[7] Arthur D. Little Inc. (ADL). 1994. *Electric Oven and Cooktop Data Analysis*. Prepared by ADL, Cambridge, MA, for Association of Home Appliance Manufacturers, Reference 47066, submitted as comment No. 001 to the NOPR, July 15, 1994.